Complete Summary

GUIDELINE TITLE

ACR Appropriateness Criteria® neuroendocrine imaging.

BIBLIOGRAPHIC SOURCE(S)

Seidenwurm DJ, Wippold FJ II, Cornelius RS, Brunberg JA, Davis PC, De La Paz RL, Dormont D, Gray L, Jordan JE, Mukherji SK, Turski PA, Zimmerman RD, Sloan MA, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria® neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 11 p. [47 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Seidenwurm DJ, Davis PC, Brunberg JA, De La Paz RL, Dormont PD, Hackney DB, Jordan JE, Karis JP, Mukherji SK, Turski PA, Wippold FJ II, Zimmerman RD, McDermott MW, Sloan MA, Expert Panel on Neurologic Imaging. Neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 11 p. [44 references]

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Endocrine disorders, including the following:

- Hypopituitarism
- Obesity/eating disorder
- Hyperthyroidism (high thyroid stimulating hormone [TSH])
- Cushing's syndrome (high adrenal corticotrophic hormone [ACTH])
- Hyperprolactinemia
- Acromegaly/gigantism
- Growth hormone deficiency, growth deceleration, panhypopituitarism
- Diabetes insipidus
- Pituitary apoplexy
- Postoperative sella
- Precocious puberty

GUIDELINE CATEGORY

Diagnosis
Evaluation

CLINICAL SPECIALTY

Endocrinology
Family Practice
Internal Medicine
Neurological Surgery
Neurology
Pediatrics
Radiology
Surgery

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for patients with endocrine disorders

TARGET POPULATION

Patients with endocrine disorders

INTERVENTIONS AND PRACTICES CONSIDERED

1. Magnetic resonance imaging (MRI), head
    - Without contrast
    - Without and with contrast
2. Magnetic resonance angiography (MRA), head

3. Computed tomography (CT), head
    - Without contrast
    - Without and with contrast
    - With contrast
4. CT angiography (CTA), head
5. X-ray
    - Sella
    - Head, tomography
6. Invasive (INV)
    - Cerebral arteriography
    - Venous sampling, petrosal sinus

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals, and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by the participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Neuroendocrine Imaging

Variant 1: Hypopituitarism.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without contrast	4	Indicated if MRI not available or contraindicated.	Med
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
MRA head with or without contrast	3	Indicated if better visualization of carotid arteries needed.	None
CTA head	2	For surgical planning of vascular detail if MRI and MRA contraindicated.	Med
X-ray tomography head	1		Min
X-ray sella	1		Min
INV arteriography cerebral	1		Med
INV venous sampling petrosal sinus	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Obesity/eating disorder.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	4	In carefully selected patients with high clinical likelihood of structural abnormality. Multiplanar thin sellar imaging.	None
MRI head without and with contrast	4	In carefully selected patients with high clinical likelihood of structural abnormality. Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
CT head without contrast	3	Indicated if MRI not available or contraindicated. In selected patients with high clinical likelihood of structural abnormality.	Med
CT head without and with contrast	3	Indicated if MRI not available or contraindicated. In selected patients with high clinical likelihood of structural abnormality.	Med
MRA head with or without contrast	2		None
X-ray sella	1		Min
INV arteriography cerebral	1		Med
INV venous sampling petrosal sinus	1		IP
X-ray tomography head	1		Min
CTA head	1		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Hyperthyroidism (high TSH).

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without contrast	3	Indicated if MRI not available or contraindicated.	Med
CT head without and with contrast	3	Indicated if MRI not available or contraindicated.	Med
MRA head with and without contrast	3		None
CTA head	2	For surgical planning or vascular detail if MRI and MRA contraindicated.	Med
INV arteriography cerebral	1		Med
X-ray tomography head	1		Min
X-ray sella	1		Min
INV venous sampling petrosal sinus	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Cushing's syndrome (high ACTH).

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
INV venous sampling petrosal sinus	4	Indicated if MRI is negative or equivocal.	IP
CT head without contrast	4	Indicated if MRI not available or contraindicated.	Med
MRA head with or without contrast	3	Indicated if better visualization of carotid arteries needed.	None
CTA head	2		Med
X-ray sella	1		Min
INV arteriography cerebral	1		Med
X-ray tomography head	1		Min
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Hyperprolactinemia.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
CT head without	4	Indicated if MRI not available or	Med

Radiologic Procedure	Rating	Comments	RRL*
contrast		contraindicated.	
MRA head with or without contrast	3	Indicated if better visualization of carotid arteries needed.	None
CTA head	2	For surgical planning or vascular detail if MRI and MRA contraindicated.	Med
X-ray sella	1		Min
INV venous sampling petrosal sinus	1	Indicated in unusual cases in which lateralization is indeterminate.	IP
INV arteriography cerebral	1		Med
X-ray tomography head	1		Min
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Acromegaly/gigantism.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
CT head without contrast	4	Indicated if MRI not available or contraindicated.	Med
INV venous sampling petrosal sinus	3	Indicated in unusual cases in which lateralization is indeterminate.	IP

Radiologic Procedure	Rating	Comments	RRL*
MRA head with or without contrast	3	Indicated if better visualization of carotid arteries needed.	None
CTA head	2	For surgical planning or vascular detail if MRI and MRA contraindicated	Med
X-ray sella	1		Min
X-ray tomography head	1		Min
INV arteriography cerebral	1		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Growth hormone deficiency, growth deceleration, panhypopituitarism.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
MRI head without and with contrast	5	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
CT head without contrast	4	Indicated if MRI not available or contraindicated.	Med
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
MRA head with or without contrast	2		None
CTA head	2	For surgical planning or vascular detail if MRI and MRA contraindicated.	Med
INV arteriography cerebral	1		Med

Radiologic Procedure	Rating	Comments	RRL*
X-ray tomography head	1		Min
X-ray sella	1		Min
INV venous sampling petrosal sinus	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Diabetes insipidus.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
MRI head without and with contrast	6	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRA head with or without contrast	4	See comments regarding contrast in the text below under "Anticipated Exceptions."	None
CT head without contrast	4	Indicated if MRI not available or contraindicated.	Med
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
CTA head	2	For surgical planning or vascular detail if MRI and MRA contraindicated.	Med
INV venous sampling petrosal sinus	1		IP
X-ray tomography head	1		Min

Radiologic Procedure	Rating	Comments	RRL*
INV arteriography cerebral	1		Med
X-ray sella	1		Min
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Pituitary apoplexy.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without contrast	6		Med
MRA head with or without contrast	4	Indicated if better visualization of carotid arteries needed. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
CT head without and with contrast	4	Indicated if MRI not available or contraindicated.	Med
CTA head	4		Med
X-ray tomography head	1		Min
INV venous sampling petrosal sinus	1		IP
INV arteriography cerebral	1		Med
X-ray sella	1		Min

Radiologic Procedure	Rating	Comments	RRL*
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 10: Postoperative sella.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without and with contrast	4	CT may be indicated to assess bony anatomy and if MRI is not available or contraindicated.	Med
CT head without contrast	4	CT may be indicated to assess bony anatomy and if MRI is not available or contraindicated.	Med
CTA head	4		Med
MRA head with or without contrast	2		None
X-ray sella	1		Min
X-ray tomography head	1		Min
INV arteriography cerebral	1		Med
INV venous sampling petrosal sinus	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 11: Precocious puberty.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	Multiplanar thin sellar imaging. See comments regarding contrast in the text below under "Anticipated Exceptions."	None
MRI head without contrast	7	Multiplanar thin sellar imaging.	None
CT head without contrast	2		Med
CT head with contrast	2	If MRI not available or contraindicated	Med
CTA head	2		Med
MRA head with or without contrast	2		None
X-ray sella	1		Min
X-ray tomography head	1		Min
INV arteriography cerebral	1		Med
INV venous sampling petrosal sinus	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

The imaging approach to the hypothalamic pituitary axis is based on specific endocrine testing suggested by clinical signs and symptoms. Endocrine disorders are generally characterized by excess or deficiency of specific hormones. Hormone excess is diagnosed under conditions that would ordinarily suppress hormone secretion. Endocrine deficiencies are diagnosed on the basis of hormone

measurements under conditions of stimulation. Specific clinical syndromes of hormonal disorders are determined by the physiologic role of that particular hormone.

The hypothalamic pituitary axis consists of two separate neuroendocrine organs: the anterior pituitary system and the posterior pituitary system. The hormones of the anterior pituitary are thyroid-stimulating hormone (TSH), adrenal corticotrophic hormone (ACTH), prolactin (PRL), growth hormone (GH), and the gonadotropins (follicle stimulating hormone [FSH] and luteinizing hormone [LH]). These are secreted under the influence of hypothalamic trophic factors, corticotrophin releasing factor (CRF), thyrotropin releasing factor (TRF) and somatostatin- and gonadotropin-releasing hormone (GnRH). Prolactin release is under the control of a dopaminergic circuit. The hypothalamic-releasing hormones are transported to the pituitary gland by the hypophyseal portal system.

The posterior pituitary gland consists of axonal terminations of neurons whose cell bodies are located in the hypothalamus. The principal hormones secreted by these cells are oxytocin and vasopressin or antidiuretic hormone (ADH). The hypothalamus also participates in complex mediation of food intake, temperature regulation, sleep and arousal, memory, thirst, and other autonomic functions.

Structural causes of obesity, anorexia, central hypothermia and hyperthermia, insomnia and hypersomnia are only very rarely demonstrated in the hypothalamus and pituitary gland. Imaging in patients who present with these symptoms absent other specific neurological or endocrine abnormality is almost always unrewarding. An exception is in children in whom the "diencephalic syndrome" of hypothalamic lesions is relatively common. Also precocious puberty in children can result from hypothalamic lesions.

Pituitary adenomas are the most common lesions of the pituitary gland. These may secrete prolactin, TSH, GH, ACTH, or gonadotropins. Prolactinomas are the most common and are generally present as microadenomas in premenopausal females with amenorrhea and galactorrhea. Prolactin (PRL) elevation by itself is nonspecific and may be due to a variety of medical, neurological, or pharmacological causes as well as pituitary adenoma, depending on serum hormone level. In males, prolactinomas may be entirely asymptomatic until visual symptoms occur, due to compression of the chiasm, or they may result in hypogonadotropic hypogonadism with loss of libido and impotence. Growth-hormone-secreting tumors generally present as larger lesions manifesting clinical acromegaly. Because of the gradual onset of deformity, these tumors may be present for many years and grow to substantial size prior to their detection. In a prepubertal individual the growth-hormone-secreting tumor may result in gigantism. TSH- and ACTH-secreting tumors may present at very small size because the impact of their hormone product is usually apparent more rapidly. Gonadotropin-secreting tumors are rare.

Precocious puberty and other neurological symptoms can be produced by hypothalamic lesions such as hamartoma. MRI is generally indicated in all patients with endocrinologically confirmed precocious puberty, especially when rapid progression of development and neurological symptoms are present.

Posterior pituitary dysfunction with loss of antidiuretic hormone results in the clinical syndrome of diabetes insipidus. This may occur as a transient phenomenon after trauma or neurosurgical procedures. The etiology is usually evident, and the phenomenon is frequently transient. Imaging is performed to search for the cause of stalk transsection, which can be a manifestation of numerous sellar or parasellar pathologies, trauma, or congenital. Rarely, the hormone is absent developmentally. The syndrome of inappropriate antidiuretic hormone (SIADH) is usually due to an extracranial source. Frequently this is a paraneoplastic phenomenon related to small-cell lung carcinoma, though a variety of pulmonary diseases and pharmacological disturbances can result in SIADH.

Other common mass lesions that may affect the neuroendocrine system are germ-line tumors, meningioma, craniopharyngioma, and Rathke's cleft cyst among others. Metastatic lesions may affect the sella. Sarcoid and other inflammatory processes occur in the sellar and suprasellar regions as well. Pituitary apoplexy is a syndrome of headache ophthalmoplegia and visual loss that results from pituitary hemorrhage. In the postpartum period, pituitary infarcts may occur, and hypophysitis is an uncommon disorder resulting in endocrine disturbance and other symptoms.

Classically, radiography and pluridirectional x-ray tomography were the mainstays of sellar imaging. Computed tomography (CT) largely replaced these modalities through the seventies and eighties. More recently, magnetic resonance imaging (MRI) has largely supplanted CT. MRI for sellar pathology includes thin-section multiplanar imaging with slice thickness of 3 mm or less, often before and after contrast administration. Other techniques that are used for evaluation of this anatomical region are computed tomography angiography (CTA), magnetic resonance angiography (MRA), direct catheter angiography, and petrosal sinus sampling.

Radiography and pluridirectional tomography are insensitive and nonspecific imaging modalities for evaluating sellar pathology. Pituitary microadenoma and even small pituitary macroadenomas are frequently associated with a normal sella size. The sella turcica can be enlarged when no neoplasm or mass is present. This is due to pulsations of cerebral spinal fluid (CSF) transmitted through a developmental or acquired dehiscence of the diaphragm sella in the empty sella syndrome. Therefore, these imaging modalities are rarely, if ever, used productively in the evaluation of endocrine disease.

CT revolutionized evaluation of the sella and suprasellar region. Due to the ability of CT, especially with intravenous contrast, to depict pathology within the unenlarged sella, and its ability to visualize suprasellar pathology noninvasively, this technique facilitates accurate diagnosis of neuroendocrine abnormality. Pituitary microadenomas and macroadenomas are reliably detected. It is, however, difficult at times to distinguish the tumor from the optic chiasm and to diagnose cavernous invasion. Also, cystic lesions of the suprasellar region may be confused with normal CSF.

Additionally, artifact due to dental amalgam, difficulty in obtaining reliable contrast enhancement and awkward positioning for direct coronal scanning limit the utility of this imaging modality. In the hands of experienced radiologists this

technique can result in excellent diagnostic accuracy, though the examinations are sometimes hard to interpret despite excellent technique.

MRI provides excellent noninvasive evaluation of the hypothalamus and pituitary gland. It is the only imaging modality that reliably depicts the hypothalamus in a useful fashion. It depicts the anatomy of the pituitary gland, infundibulum, optic chiasm, cavernous sinuses and neighboring vascular structures accurately and noninvasively.

The addition of gadolinium facilitates diagnosis of microadenoma and increases the confidence with which cavernous sinus invasion can be diagnosed or excluded. The specific bony landmarks may be difficult to demonstrate but the signal pattern of sphenoid sinus mucosa permits assessment of septa for operative planning. Visualization of vascular structures in the parasellar region or even intrasellar carotid artery loop or aneurysm is crucial in some cases.

Angiography is reserved for those patients in whom vascular pathology is known or suspected on the basis of clinical or radiological findings. Aneurysm is the most important vascular lesion in the parasellar region, but these lesions rarely present as endocrine disorders. Knowledge of vascular anatomy guides surgery. Occasionally, a sellar lesion may grow to displace or encase the carotid arteries or other major intracranial vessels. Interventional neuroradiology procedures can be planned on the basis of CTA, MRA, or catheter angiography.

Petrosal sinus venous sampling is reserved for those cases in which a definite excess of pituitary hormone is present, medical management has failed, sectional imaging is negative or equivocal and surgery is planned. When a significant discrepancy in hormone level, usually ACTH, exists between the vessels studied, tumor localization is very accurate. Complications occur uncommonly in experienced hands.

A significant problem encountered in CT and MRI of the pituitary, particularly when endocrine findings suggest microadenoma, is the false positive examination. Since the endocrine studies confirm the presence of a lesion, and first-line therapy is usually medical, false negative examinations are less problematic once chiasmatic compression has been excluded. Approximately 20% of the population may harbor small incidental nonfunctioning adenomas or cysts. It is important, therefore, that the probability of disease be high in the target population if positive MRI is to be relied upon for surgical planning. Additional problems are created by variations in size of the pituitary gland, which occur normally in response to physiological hormonal changes. The gland may enlarge in puberty and pregnancy. Pituitary hyperplasia in hypothyroidism may simulate a pituitary adenoma in some patients. Similar problems arise in imaging the posterior pituitary since up to 29% of normal subjects do not demonstrate a bright posterior pituitary.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF, also known as nephrogenic fibrosing dermopathy) was first identified in 1997 and has recently generated substantial concern among radiologists, referring doctors and lay people. Until the last few years, gadolinium-based MR contrast agents were widely believed to be almost

universally well tolerated, extremely safe and non-nephrotoxic, even when used in patients with impaired renal function. All available experience suggests that these agents remain generally very safe, but recently some patients with renal failure who have been exposed to gadolinium contrast agents (the percentage is unclear) have developed NSF, a syndrome that can be fatal. Further studies are necessary to determine what the exact relationships are between gadolinium-containing contrast agents, their specific components and stoichiometry, patient renal function and NSF. Current theory links the development of NSF to the administration of relatively high doses (e.g., >0.2mM/kg) and to agents in which the gadolinium is least strongly chelated. The U.S. Food and Drug Administration (FDA) has recently issued a "black box" warning concerning these contrast agents (http://www.fda.gov/cder/drug/InfoSheets/HCP/gcca_200705HCP.pdf).

This warning recommends that, until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated glomerular filtration rate [GFR] <30 mL/min/1.73m^2), recent liver or kidney transplant or hepato-renal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in the particular patient clearly outweighs the potential risk(s).

Abbreviations

- ACTH, adrenal corticotrophic hormone
- CT, computed tomography
- CTA, computed tomography angiography
- INV, invasive
- Med, medium
- Min, minimal
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- TSH, thyroid stimulating hormone

Relative Radiation Level	Effective Dose Estimated Range
None	0
Minimal	<0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv
*RRL assignments are not included for some examinations. The RRL assignments for the IP (in progress) exams will be available in future releases.	

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of patients with endocrine disorders

POTENTIAL HARMS

- False-positive results in computed tomography and magnetic resonance imaging examinations of the pituitary are possible, particularly when endocrine findings suggest microadenoma.
- Some patients with renal failure who have been exposed to gadolinium contrast agents (the percentage is unclear) have developed nephrogenic systemic fibrosis (NSF), a syndrome that can be fatal. The U.S. Food and Drug Administration (FDA) has recently issued a "black box" warning concerning these contrast agents. This warning recommends that, until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated glomerular filtration rate [GFR] <30 mL/min/1.73m^2), recent liver or kidney transplant or hepato-renal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in the particular patient clearly outweighs the potential risk(s).

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging

examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Seidenwurm DJ, Wippold FJ II, Cornelius RS, Brunberg JA, Davis PC, De La Paz RL, Dormont D, Gray L, Jordan JE, Mukherji SK, Turski PA, Zimmerman RD, Sloan MA, Expert Panel on Neurologic Imaging. ACR Appropriateness Criteria®

neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 11 p. [47 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1999 (revised 2008)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Neurologic Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: David J. Seidenwurm, MD; Franz J. Wippold II, MD; Rebecca S. Cornelius, MD; James A. Brunberg, MD; Patricia C. Davis, MD; Robert L. De La Paz, MD; Pr. Didier Dormont; Linda Gray, MD; John E. Jordan, MD; Suresh Kumar Mukherji, MD; Patrick A. Turski, MD; Robert D. Zimmerman, MD; Michael A. Sloan, MD, MS

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Seidenwurm DJ, Davis PC, Brunberg JA, De La Paz RL, Dormont PD, Hackney DB, Jordan JE, Karis JP, Mukherji SK, Turski PA, Wippold FJ II, Zimmerman RD, McDermott MW, Sloan MA, Expert Panel on Neurologic Imaging. Neuroendocrine imaging. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 11 p. [44 references]

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following are available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria® radiation dose assessment introduction. American College of Radiology. 2 p. Electronic copies: Available from the American College of Radiology Web site.

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on July 31, 2001. The information was verified by the guideline developer as of August 24, 2001. This summary was updated by ECRI on August 17, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on July 2, 2009.

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